Table 4.2. Panel Members of Regional Biologists Who Developed the Criteria Used to Screen Study Area Species

Pacific Northwest National Laboratory	Federal and State Resource Management Agencies
D. Becker	L. Block (U.S. Fish and Wildlife Service)
C. Brandt	P. Camp (Bureau of Land Management)
C. Cushing	C. Christiansen (U.S. Army Corps of Engineers)
D. Dauble	G. Dorsey (U.S. Army Corps of Engineers)
S. Friant	L. Fitzner (Washington Department of Wildlife)
D. Geist	D. Linehan (U.S. Fish and Wildlife Service)
J. Hall	G. McCabe (National Marine Fisheries Service)
D. Maughan	L. Mettler (U.S. Army Corps of Engineers)
R. Mazaika	S. Norwood (Washington Department of Natural Resources)
D. Neitzel	T. Panskey (Bonneville Power Administration)
W. Rickard	D. Pock (Grant County Public Utility District)
M. Sackschewsky	D. Rondorf (National Biological Survey)
D. Schreffler	B. Shank (Bonneville Power Administration)
	D. Yon (Oregon Department of Environmental Quality)

- critical component of either the riparian or aquatic ecosystem: key predator or prey
- high potential exposure to contaminants
- availability of toxicological information for the species (Note: This is independent of ecological significance.)
- representativeness of a foraging guild
- exotic versus native species

The panel gave each species a positive or negative response to each of the six criteria. Three or more positive responses were selected as an arbitrary cutoff for inclusion, resulting in selection of 93 (roughly 25 percent) of the 368 study area species. These 93 species were submitted to the CRCIA Team for review and input. An additional 88 species (based on their cultural and ecological importance) were provided by the CRCIA Team to create a list of 181 Tier I species (Table 4.3 and C.2 in Appendix I-C). These species provided a balanced representation of the taxonomic groups in the study area list and were thus identified for further evaluation in the screening assessment of ecological risk.

Table 4.3. Number of Species by Taxonomic Group at Various Stages of the Tier I Screening Process

Stages	Algae	Amphibians	Aquatic Invertebrate	Birds	Emergent Vegetation	Fish	Fungi	Macrophytes	Mammals	Reptiles	Terrestrial Invertebrates	Terrestrial Vegetation	Total
No. of Study Area Species on the Master List	17	6	12	112	21	51	0	5	30	1	1	112	368
No. of Study Area Species Selected by Panel Screening	12	2	9	29	7	17	0	5	9	0	0	3	93
Percent of Study Area Species Selected by Panel Screening	71%	33%	75%	26%	33%	33%	0%	100%	31%	0%	0%	3%	25%
No. of Species Added by the CRCIA Team	0	2	6	19	1	7	1[(a)]	0	12	7	7	26	88
Total No. of Tier I Species[(b)]	12	4	15	48	8	24	1	5	21	7	7	29	181
Percent of Total Number of Tier I Species	7%	2%	8%	26%	4%	13%	1%	3%	12%	4%	4%	16%	100%

(a) Fungi were added by the CRCIA Team as a broad taxonomic group and were evaluated as such in the Tier II species screen.
(b) The number of Tier I species was derived by summing the number of study area species identified by the panel with the number of species added by the CRCIA Team.

4.1.2.2 Tier II Species Screen

This section describes the details of the various screens used to arrive at the species on the Tier II list.

A list of Tier II species was identified using the following protocol. A conceptual exposure model approved by the CRCIA Team and for the study area was used to rank the 181 Tier I species based on a scoring of their exposure to contaminants and acute radiation sensitivity (see Section 4.2.2, Figures 4.4 and 4.5). In the model, species scores were assigned based on the following:

- potential dietary exposure to biomagnifying and non-biomagnifying contaminants
- potential dermal and inhalation exposure to contaminants
- potential exposure to contaminated media weighted to reflect the relative importance of these contaminated media at the two types of source areas (effluent pipes and in-river, see Section 4.1.2.2.8)
- exposure duration
- acute radiation sensitivity

The resulting ranks, which indicated the qualitative, relative exposure of species within taxonomic groups, were presented to the CRCIA Team. The CRCIA Team then identified 65 of these as tentative Tier II species based on their rank and cultural and ecological importance. These 65 were further reduced to 52 final Tier II species by excluding 1) those with a life style similar to that of another Tier II species, 2) those with low average summary scores (see Section 4.1.2.2.11), and 3) those that virtually never occur in the river or riparian zone. The contaminant exposures and effects of these 52 Tier II species were analyzed in the screening assessment of ecological risk (the results are presented in Section 4.2).

4.1.2.2.1 Methods. In general, the magnitude of an individual's exposure to a contaminant is a function of the following:

- concentration of the contaminant in the media (air, groundwater, prey, sediment, soil, and surface water) contacted by the individual
- number of media contacted by the individual
- number of pathways (dermal, ingestion, and inhalation) by which contaminated media may enter the organism
- duration of an individual's contact with the contaminated media

To arrive at a simplified conceptual exposure model, species were first grouped by life style as either fully aquatic, semi-aquatic, or primarily riparian. Within life styles, species were grouped primarily by major taxonomic groups, for example, amphibian, bird, fish, insect, mammal, plant, and reptile. Within taxonomic groups, species were grouped largely by trophic level, for example, carnivore, herbivore, and omnivore. The species in each taxonomic group and trophic level were evaluated to determine their potential exposure to contaminated abiotic media (air, groundwater, pore water, sediment, soil, and surface water) at source areas believed to have contaminant loads sufficient to pose a substantial hazard at one or more critical life stages using a general conceptual exposure model approved by the CRCIA Team (see Figures 4.4 and 4.5 in Section 4.2.2).

The contaminant source areas are shown in Table 4.4 and evaluated further in Section 4.1.2.2.8. Results of the evaluation to determine potential exposure to contaminanted abiotic media are shown in Tables 4.5, 4.6, and 4.7 for aquatic, semi-aquatic, and terrestrial species, respectively. Exposure to biotic media, such as prey, is addressed in Section 4.1.2.2.2.

Table 4.4. Contaminant Source Areas and Their Potentially Contaminated Media within the Study Area

Contaminant Source Areas	Media					
	Sediment	Surface Water	Pore Water	Groundwater	Soil	Air
Effluent Pipes	◷	◷	◷	◷	◷	◷
In-River						
McNary Pool	◷	◷	◷			
Sloughs	◷	◷	◷			
Deep Holes	◷	◷	◷			
Near-Shore Areas	◷	◷	◷			
Seep/Spring		◷		◷	◷	◷

Note: Filled cells indicate contaminated media at the source areas. Blank cells indicate media at the source areas that are not contaminated or have very low contamination levels relative to the other media.

Of the 181 Tier I species, some were grouped based on similar life styles and trophic levels, resulting in 121 species. The CRCIA Team added 5 species to the 121 for a total of 126 species. The 126 species were scored, using the conceptual exposure model described above, for their potential exposure to contaminated media. Scores were scaled to reflect the general magnitude of a species potential exposure to contaminants in each medium, the duration of exposure, and acute radiation sensitivity. These scores represent an index of the relative exposure of species within taxonomic groups. Species were scored specifically on the following:

- Exposure to Biotic and Abiotic Media: Exposure to media occurs when a species 1) ingests prey, sediment/soil, pore water/groundwater, or surface water that is contaminated, 2) comes in dermal contact with those media, or 3) inhales airborne contaminants. Scores were assigned to each species

Table 4.5. General Conceptual Exposure Model Depicting Generic Exposure Pathways/Abiotic Media for Several Aquatic Species

Primary Group	Secondary Group/Species	Exposure Pathways/Abiotic Media					
		Dermal Exposure[a]			Ingestion Exposure[b]		
		Sediment	Pore Water/ Groundwater	Surface Water	Sediment	Pore Water/ Groundwater[c]	Surface Water[c]
Primary Producers	Algae	⏱[d]	⏱	⏱	NA[e]	NA	NA
	Macrophytes	⏱	⏱	⏱	NA	NA	NA
Invertebrates	Benthos	⏱	⏱	⏱	⏱	⏱	⏱
	Zooplankton			⏱			⏱
	Macroscopic Arthropods	⏱	⏱	⏱	⏱	⏱	⏱
	Mollusks	⏱	⏱	⏱	⏱	⏱	⏱
Resident Fish	Herbivores; e.g., ◆ sucker	⏱[f]	⏱[f]	⏱	⏱	⏱	⏱
	Carnivores;[g] e.g., ◆ rainbow trout ◆ squawfish ◆ sturgeon ◆ bass	⏱[f]	⏱	⏱	⏱[h]	⏱[h]	⏱
Non-resident Fish; i.e., Anadromous Species	Carnivores; e.g., ◆ lamprey ◆ shad ◆ chinook salmon	⏱[f]	⏱[f]	⏱	Anadromous species do not feed in the river		
Amphibians	Bullfrog	⏱[f]	⏱[f]	⏱	⏱[i]	⏱[i]	⏱[i]

Note: Filled cells indicate scenarios where exposure pathways are complete at one or more life stages. Blank cells indicate scenarios where exposure pathways are incomplete.

(a) The term refers to all exposure via external body surfaces. Dermal exposure to surface water includes exposure via respiration of water. Exposure via respiration of water is assumed to be a complete pathway for all these aquatic species except the bullfrog. The air inhalation pathway was not included here because it applies only to the bullfrog. For the bullfrog, the air inhalation pathway is assumed to be complete.
(b) Ingestion of biotic media (prey) is described in Section 4.1.2.2.2 and Table 4.8.
(c) Aquatic species ingest water only incidental to prey consumption.
(d) All ⏱ = Exposure at all life stages unless otherwise indicated.
(e) NA = Not Applicable.
(f) Exposure of eggs through swim-up stage.
(g) Carnivorous fish include those which ingest invertebrates and/or other fish.
(h) None for piscivores.
(i) Exposure of larvae only.

for each medium. For the ingestion of prey, scores were differentiated depending on whether the contaminants were biomagnifying or non-biomagnifying. All media scores were scaled from 1 to 4 to ensure that all pathways/media were considered of equal importance in their contribution to an individual's overall exposure. In some pathway/media exposure scenarios, scores were scaled from 0 to 4 (see Sections 4.1.2.2.3-4.1.2.2.6) because these scenarios included the possibility of no exposure. The use of the zero, however, did not change the sum of the species' scores or the ultimate rankings. Sections 4.1.2.2.2-4.1.2.2.8 describe the basis and provide examples of the score assignments.

Table 4.6. General Conceptual Exposure Model Depicting Generic Exposure Pathways/Abiotic Media for Several Semi-Aquatic Species

Primary Group	Secondary Group/Species	Exposure Pathways/Abiotic Media[a]					
		Dermal Exposure			Ingestion Exposure[b]		
		Sediment/ Soil	Pore Water/ Groundwater	Surface Water	Sediment/ Soil	Pore Water/ Groundwater	Surface Water
Plants	Emergent Vegetation	◷[c]	◷	◷	NA[d]	NA	NA
Birds	Wading Birds and Aquatic Insectivores	◷		◷	◷	◷	◷
	Piscivores; e.g., ◆ merganser ◆ loon ◆ pelican ◆ cormorant	◷[e]		◷	◷		◷
	Herbivores; e.g., ◆ redhead duck ◆ goose/mallard	◷[e]		◷	◷		◷
Mammals	Carnivores; e.g., ◆ river otter	◷		◷			◷
	Herbivores; e.g., ◆ beaver	◷		◷	◷		◷
	Omnivores; e.g., ◆ muskrat	◷		◷	◷	◷	◷
Amphibians	Woodhouse's toad	◷	◷[f]	◷	◷[f]	◷[f]	◷[f]

Note: Filled cells indicate scenarios where exposure pathways are complete at one or more life stages. Blank cells indicate scenarios where exposure pathways are incomplete.

(a) The air inhalation pathway was not included here because it is assumed to be complete for these semi-aquatic species.
(b) Ingestion of biotic media (prey) is described in Section 4.1.2.2.2 and Table 4.8.
(c) All ◷ = Exposure at all life stages unless otherwise indicated.
(d) NA = Not Applicable.
(e) Includes preening exposure.
(f) Exposure of larvae only.

- Exposure Duration: Scores scaled from 1 to 4 were assigned to each species based on the amount of time they reside in the study area. Section 4.1.2.2.9 describes the basis and provides examples of the score assignments.

- Acute Radiation Sensitivity: For exposure to radiation, scores scaled from 1 to 4 were assigned to each species based on the dose that is lethal to 50 percent of test organisms (LD_{50}) (Whicker and Schultz 1982). Section 4.1.2.2.10 describes the basis and provides examples of the score assignments.

Three types of score summaries were performed. First, scores of exposure to media were summed separately for biomagnifying and non-biomagnifying contaminants with all media assumed to contribute equally to exposure. Second, media scores were weighted to reflect the degree of exposure to

Table 4.7. General Conceptual Exposure Model Depicting Generic Exposure Pathways/Abiotic Media for Several Terrestrial Species

Primary Group	Secondary Group/Species	Exposure Pathways/Abiotic Media[a]					
		Dermal Exposure			Ingestion Exposure[b]		
		Soil	Groundwater	Surface water	Soil	Groundwater	Surface Water
Plants	Deep-Rooted	✓[c]	✓	✓	NA[d]	NA	NA[d]
	Shallow-Rooted	✓		✓	NA	NA	NA
Insects	Insects	✓		✓	✓		✓
Birds	Insectivores; e.g., ◆ swallow ◆ kingbird	✓[e]		✓	✓		✓
	Carnivores; e.g., ◆ kingfisher ◆ bald eagle ◆ osprey	✓[e]		✓			✓
Mammals	Bats						✓
	Insectivores; e.g., ◆ shrew ◆ grasshopper mouse	✓		✓	✓		✓
	Herbivores; e.g., ◆ mice ◆ porcupine ◆ deer	✓		✓	✓		✓
	Carnivores/Omnivores; e.g., ◆ coyote ◆ skunk	✓		✓			✓
Reptiles	Lizards	✓			✓		
	Snakes	✓		✓	✓		

Note: Filled cells indicate scenarios where exposure pathways are complete at one or more life stages. Blank cells indicate scenarios where exposure pathways are incomplete.

(a) The air inhalation pathway is not included here because it is assumed to be complete for these terrestrial species.

(b) Ingestion of biotic media (prey) is described in Section 4.1.2.2.2 and Table 4.8.

(c) All ✓ = Exposure at all life stages unless otherwise noted.

(d) NA = Not Applicable.

(e) Includes preening exposure.

contaminants at the two types of source areas (in-river and effluent pipes, see Section 4.1.2.2.8). Weighted scores were summed for biomagnifying and non-biomagnifying contaminants at the two types of source areas. Weighted scores were averaged across source areas and across biomagnifying and non-biomagnifying contaminants to obtain a grand average exposure score. Species were ranked based on these grand average exposure scores. Third, grand average exposure scores (divided by 15 to retain the same scale as exposure duration and acute radiation sensitivity) were added to exposure duration and acute radiation sensitivity scores to obtain a single composite score. Species were also ranked based on these composite scores.

All rankings were assigned within taxonomic groups (algae, amphibians, aquatic invertebrates, birds, emergent vegetation, fish, fungi, macrophytes, mammals, reptiles, terrestrial invertebrates, and terrestrial vegetation). These ranks indicated the qualitative, relative exposure of species within taxonomic groups. The results of the scoring are shown in Table C.3 in Appendix I-C. The following sections explain the basis of the score assignments and thus the ultimate rankings.

4.1.2.2.2 Biotic Ingestion Pathway: Exposure to Contaminants in Prey. The magnitude of an individual's ingestion exposure due to consumption of prey depends on the composition of the individual's prey, the quantity of prey, and the contaminant body burdens of the various prey. The latter is related to the predator's position in the food chain (Figures 4.1 and 4.2) and whether biomagnifying or non-biomagnifying contaminants are present. Biomagnifying contaminants are those that occur in higher concentrations at higher food chain levels through dietary accumulation. Non-biomagnifying contaminants are those that remain at the same concentration or decrease in concentration at higher levels in the food web. Consequently, species at the top of the food chain received a higher score for biomagnifying contaminants and a lower score for non-biomagnifying contaminants. Conversely, species at the base of the food chain received a lower score for biomagnifying contaminants and a higher score for non-biomagnifying contaminants (Table 4.8). For example, the bald eagle is a top level carnivore. It received a biomagnifier score of 4 and a non-biomagnifier score of 1. In contrast, the suckers are herbivores.

Table 4.8. Scoring Scheme for Tier I Species' Ingestion Exposure to Contaminants in Prey

Predator Food Chain Level	Type of Contaminant in Prey	
	Biomagnifying	**Non-Biomagnifying**
Producer	1	4
Herbivore	2	3
Omnivore	3	2
Carnivore	4	1

They received a biomagnifier score of 2 and a non-biomagnifier score of 3. Emergent vegetation is classified as a producer and received a biomagnifier score of 1 and a non-biomagnifier score of 4. (Note: individual contaminants were not identified as biomagnifying or non-biomagnifying but rather were grouped only generically as such.)

4.1.2.2.3 Abiotic Ingestion Pathway: Exposure to Contaminants in Sediment/Soil and Pore Water/Groundwater. The magnitude of an individual's ingestion exposure to contaminants in sediment/soil and pore water/groundwater depends on the frequency and intimacy of an individual's contact with these media. Species whose foraging and life style allow frequent ingestion of sediment/soil and pore water/groundwater throughout their entire lives received a higher score. Species whose foraging and life style allow only occasional ingestion of these media throughout only a portion of their

lives received a lower score (Table 4.9). For example, channel catfish forage on the river bottom throughout most of their lives, where they ingest sediment and pore water incidental to consumption of benthic invertebrates. Thus, channel catfish received a score of 4 for ingestion of these media. Chinook salmon feed in the river only as juveniles when they feed both in the water column and on the river bottom. Thus, they occasionally ingest sediment and pore water incidental to consumption of aquatic insect larvae. Although adult chinook return to the study area to spawn, they do not feed during their up-river migration or spawning. Thus, chinook received a score of 1 for ingestion of sediment and a score of 1 for ingestion of pore water.

Table 4.9. Scoring Scheme for Tier I Species' Ingestion Exposure to Contaminants in Sediment/Soil and Pore Water/Groundwater

	Life Stage		
Frequency of Exposure	**Juvenile**	**Adult**	**Whole Life**
None	0	0	0
Occasional	1	1	2
Often	2	2	4

The western harvest mouse occasionally ingests soil throughout its entire life incidental to consumption of vegetation and invertebrates. The harvest mouse does not consume prey from the river. Thus, the harvest mouse received a score of 2 for ingestion of soil and a score of 0 for ingestion of pore water/groundwater. Juvenile and adult life stages were weighted the same because for most Tier II species too little toxicological information exists about general life-stage-dependent differences in sensitivities to contaminants to weight one life stage heavier than another. Where such toxicological data exist, the data have been compared with life-stage specific contaminant exposure estimates for Tier II species (see the ecological risk assessment in Section 4.2).

4.1.2.2.4 Abiotic Ingestion Pathway: Exposure to Contaminants in Surface Water. The magnitude of an individual's ingestion exposure to contaminants in surface water depends primarily on whether it drinks from the river or consumes prey from the river. Because seeps and springs at the river shoreline are small and few in number, terrestrial species' ingestion exposure to contaminants in water likely comes mostly from the river. Nonetheless, because contaminant concentrations in river water are generally much less than in seeps, springs, and groundwater, 100 percent of terrestrial animals' exposure to contaminants via ingestion of water will be estimated in the screening assessment of ecological risk (see Section 4.2) using contaminant data from seeps and springs where such data are available. Species that consume water from the river incidental to prey consumption, such as fish and benthic invertebrates, and species that both drink water and consume prey from the river, such as piscivorous birds and muskrat, all received a score of 4 for ingestion of surface water (Table 4.10). Species that drink from, but do not feed in the river, such as beaver, California quail, and owls, received a score of 2 for ingestion of surface water.

Table 4.10. Scoring Scheme for Tier I Species' Ingestion Exposure to Contaminants in Surface Water

Degree of Exposure			
Neither Drinks nor Consumes Prey from the River	**Drinks from the River**	**Consumes Prey from the River**	**Drinks and Consumes Prey from the River**
0	2	2	4

4.1.2.2.5 Dermal Pathway: Exposure to Contaminants in Sediment/Soil and Pore Water/Groundwater. Species whose life styles allow frequent dermal contact with sediment/soil and pore water/groundwater throughout their entire lives were scored higher. Species whose life style allows only occasional dermal contact with these media throughout only a portion of their lives received a lower score (Table 4.11). For example, all of the avian species occasionally bathe in dust after fledging and thus received a score of 2 for dermal exposure to soil. However, avian species that virtually never make dermal contact with sediment also will not likely make dermal contact with pore water. Thus, these received a score of 0 for this medium.

Table 4.11. Scoring Scheme for Tier I Species' Dermal Exposure to Contaminants in Sediment/Soil and Pore Water/Groundwater

Frequency of Exposure	**Life Stage**		
	Juvenile	**Adult**	**Whole Life**
None	0	0	0
Occasional	1	1	2
Often	2	2	4

All of the mammals make occasional extensive dermal contact with soil via burrowing, resting, etc., throughout their entire lives and thus received a score of 2 for dermal exposure to soil. Like birds, however, mammal species virtually never make dermal contact with pore water and thus received a score of 0 for this medium. In contrast, benthic species, such as channel catfish and aquatic invertebrates, spend most of their lives in contact with sediment and pore water and thus received a score of 4 for dermal exposure to both these media. Juvenile and adult life stages were weighted the same because for most Tier II species too little toxicological information exists about general life-stage-dependent differences in sensitivities to contaminants to weight one life stage heavier than another. Where such toxicological data exist, the data have been compared with life-stage specific contaminant exposure estimates for Tier II species (see the ecological risk assessment in Section 4.2). The data required to determine sensitivity differences at the life-stage level have been collected for use in the screening assessment of ecological risk.